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(54) **Water filtering apparatus**

(57) A granular media filter (4) is provided with means for reducing the degree of saturation of air or other gases in the water to be filtered to a level below that of equilibrium with the atmosphere prior to the water encountering the filter media so that the depth of water over the granular media in the filter can be relatively shallow without encountering the problems of "air blinding". The means comprises a deaeration unit in the form of a syphon (2) comprising a riser (5), a downcomer (7) and a cascade (6) between the riser and the downcomer, which discharges into an open passage or tank (3). Air or gas removed from the water in the cascade is re-entrained and carried down in the downcomer to the passage or tank (3) where it rises to the surface and escapes.

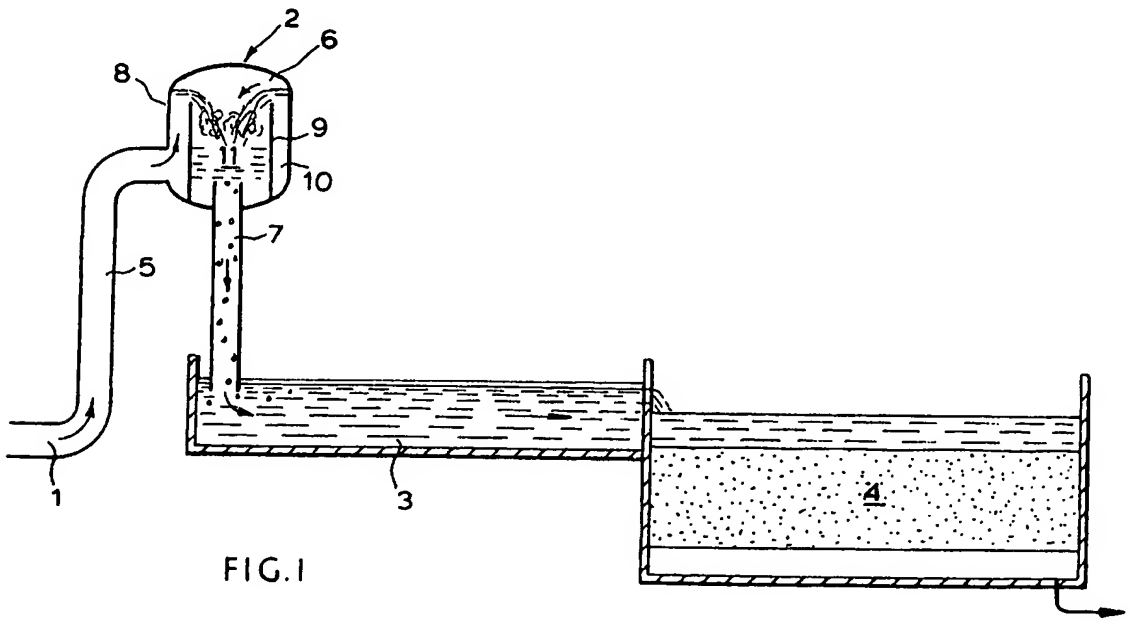

FIG.1

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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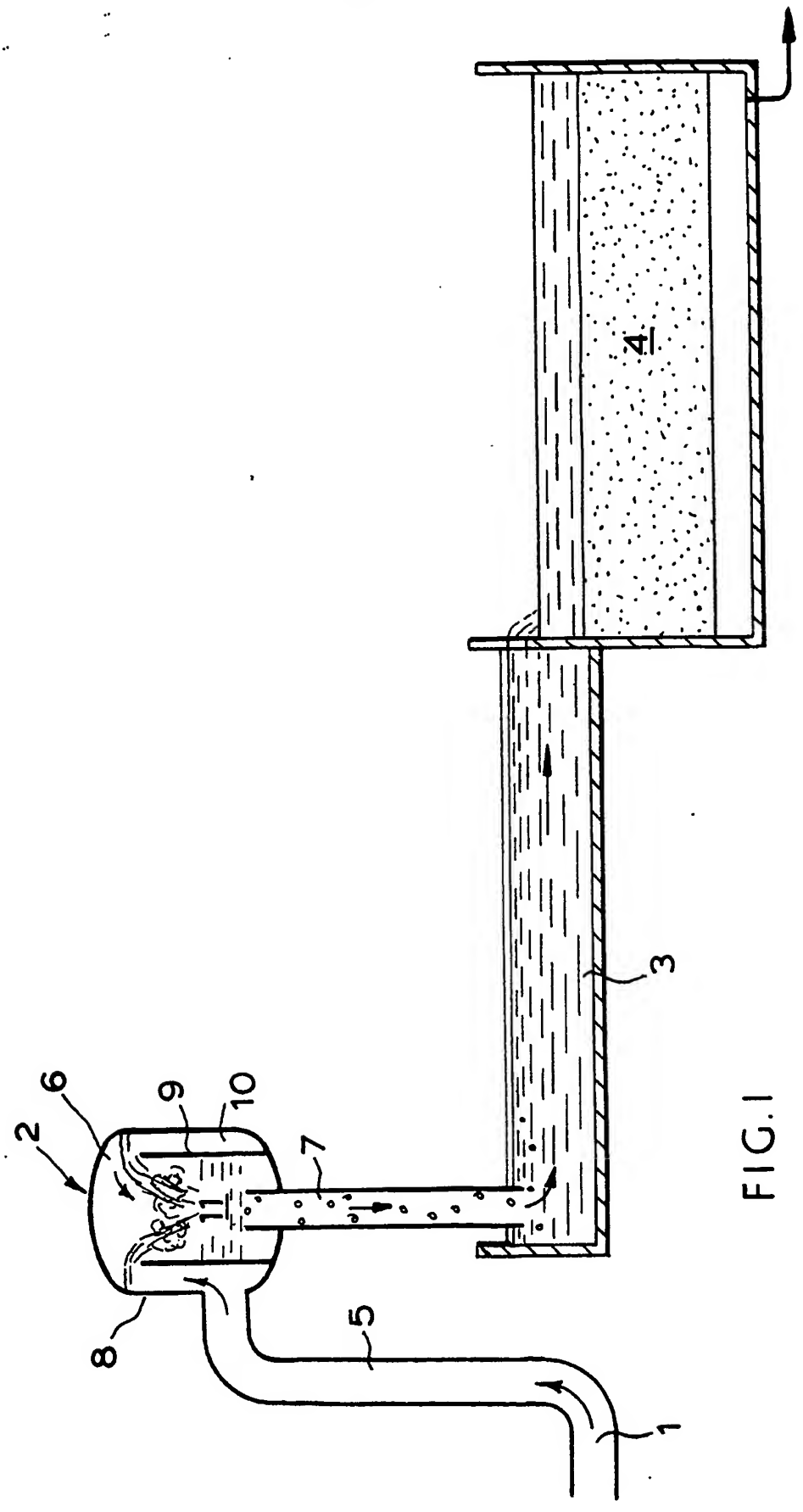

FIG.1

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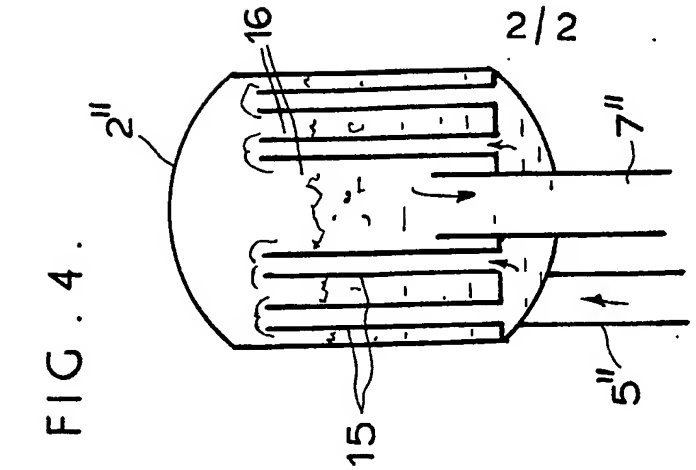

FIG. 4.

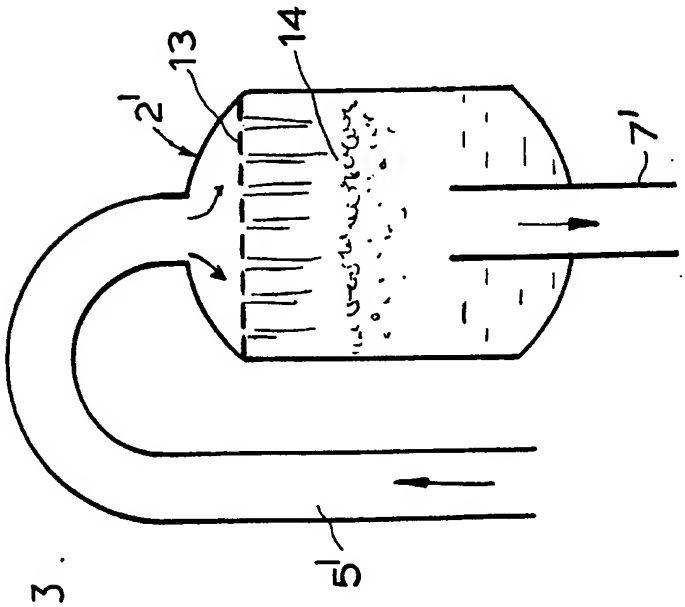

FIG. 3.

FIG. 2.

SPECIFICATION

Water filtering apparatus

This invention relates to water filtering apparatus and to a method of treating water.

In a granular media filter the solids being filtered out collect preferentially near the surface, hence in the dirty condition the pressure gradient is greatest near the surface. The absolute pressure within the water thus rises with increasing depth below the water surface by virtue of the head of water down to the surface of the media. Within the media the pressure gradient counteracts the increased hydrostatic head, thus towards the end of a filter run it is possible for the pressure gradient due to flow through the clogged media to be very high indeed so that the majority of the total pressure loss through the filter is concentrated in a few centimetres in a bed of perhaps 60—100 cm. If the depth of water over the granular media is less than the pressure loss (expressed as a head of water) through the filter, it is possible for absolute pressure just below the surface of the granular media to become sub-atmospheric, a condition known as "negative head". If this situation occurs it is possible for air dissolved in the water in equilibrium with the atmospheric pressure to come out of solution as bubbles within the interstices of the granular media and clog the pores, a condition known as "air blinding". It is therefore common practice to employ a depth of water equal to or greater than the maximum pressure or head-loss to which the filter is to run.

In order to prevent this happening, filters which do not have this feature are run at more conservative rates or use coarser sand to reduce the pressure loss but this may introduce other disadvantages such as the need for higher backwashing flow rates and a greater probability of breakthrough of suspended solids into the filtrate.

If it were not for the above mentioned problem, filters could be shallower and somewhat less expensive. Nevertheless the majority of waters to be treated are derived from surface sources such as rivers and reservoirs and are close to saturation with respect to atmospheric pressure and at times of rising temperature or in the presence of algae or waterweed may even be super saturated with air or oxygen. Air can therefore readily come out of solution if the depth of water is inadequate.

In one aspect, the present invention provides water filtering apparatus comprising a granular media filter and a deaeration unit for reducing the degree of saturation of air or other gases in the water to be filtered to a level below that of equilibrium with the atmosphere prior to the water encountering the filter media, the deaeration unit being in the form of a syphon comprising a riser, a downcomer and a cascade between the riser and the downcomer, which downcomer is arranged to discharge into an open passage or tank in use beneath the surface of water in the open passage or tank, the arrangement being such that air or gas removed from the water in the cascade is re-entrained and carried down in the downcomer to the open passage or tank where the entrained air or gas rises to the surface and escapes.

In another aspect of the invention, there is provided a method of treating water wherein the degree of saturation of natural dissolved air or other gases in the water is reduced below that of equilibrium with the atmosphere by passing the water through a deaeration unit in the form of a syphon comprising a riser, a downcomer and a cascade between the riser and the downcomer, re-entraining air or gas removed from the water in the cascade in the downcomer, and discharging the water from the lower end of the downcomer into an open passage or tank and beneath the surface of water therein where the entrained air or gas rises to the surface and escapes and from where the water is then passed to a granular media filter over which is maintained a depth of water less than that which would have been necessary to avoid air blinding of the filter had the degree of saturation of dissolved air or other gases not been reduced.

Preferably, the arrangement is such that the flow velocity in the downcomer exceeds 0.3m/sec even at the lowest working flow rate.

The term "cascade" as used herein is to be construed in its broadest sense. That is to say, it is to include weirs, perforated plates, upstanding jets and any other device which enables water to fall through a gas space before meeting the continuous body of water. It is to be construed also to include devices involving a downflow of water through a turbulent mass of air bubbles (a fluidised bed of air bubbles). The gas space may, if so desired, be filled with a packing material such as Rashig or Pall rings, Berl saddles etc.

It is thus possible to use granular media filters of shallow water depth without encountering the problems of "air blinding."

Moreover, it is possible to operate the apparatus continuously without separate means for extracting the air from the region of the cascade. However, if the deaeration unit is used between two open channels or tanks; it will be necessary to prime the syphon with a source of vacuum which may then be switched off.

The efficiency of this deaeration system need not be high, indeed it need only remove a small part of the dissolved gas to eliminate air blinding and by so doing the running cost is kept low. In a typical filter with a depth of media equal to 100 cm and the depth of the water over the media of 50 cm, saturation corresponding to only 90% of that at atmospheric pressure will be required if air blinding is to be avoided at pressure losses up to 1.5m head. A reduction of only 10% in the saturation level or possibly slightly more in the case of super saturated reservoir waters enables considerable savings to be made in the construction of open gravity filters downstream, particularly when there are several of them.

The deaeration unit could be used only when required, and in this case a bypass weir may be included to enable the filter or filters downstream to operate whilst the deaeration unit is not in service. Thus if the filters are washed in close succession the

deaeration unit may not be brought into service until the headloss of the filter reaches the point where air blinding is considered likely.

The invention will now be more particularly described with reference to the accompanying drawings, in which:

Figure 1 shows one embodiment of water filtering apparatus according to the first aspect of the invention,

Figure 2 shows another embodiment of water filtering apparatus according to the first aspect of the invention, and

Figures 3 and 4 show alternative versions of the deaeration unit for use with the apparatus shown in Figure 1 or Figure 2.

Referring firstly to Figure 1 of the drawings, water is fed under pressure through a pipeline 1 and then through a deaeration unit in the form of a syphon 2 and an open feed channel 3 to a granular media filter 4. The deaeration unit 2 comprises a riser 5, a cascade 6 and a downcomer 7. The cascade 6 is enclosed above the level of water in the inlet and feed channels in a housing 8.

The cascade 6 is formed by an annular weir 9 provided in the housing 8. The weir 9 is upstanding from the base of the housing 8 and terminates at its upper end below the top of the housing 8. The weir 9 defined an outer annular chamber 10 and an inner chamber 11. The riser 5 communicates with the lower region of the outer chamber 10. The downcomer 7 communicates at its upper end with the lower region of the inner chamber 11 and terminates at its lower end beneath the level of water in the feed channel 3.

The interior of the housing 8 may be connected at its upper end to a source of vacuum (not shown) to prime the syphon 2.

In use, water entering the outer chamber 10 flows over the weir 9 and cascades down through the inner chamber 11. Air and/or gas which is removed in the cascade, is satisfactorily re-entrained and carried down in the downcomer 7 provided that the flow velocity in the downcomer exceeds 0.3 metres/sec. The re-entrained air and/or gas rises to the surface in the feed channel 3 and escapes.

Figure 2 shows another embodiment in which the water is fed to the deaeration unit through an open inlet channel 1' instead of pipeline 1. In this case a bypass weir 12 may be connected between the inlet channel 1 and the feed channel 3 to enable the filter 4 to operate whilst the deaeration unit is not in service.

In the alternative deaeration unit 2' shown in Figure 3, the water is introduced into the top of the deaeration unit from riser 5' and is distributed across a perforated plate 13 or in another version (not shown) into notched troughs so that it cascades down over the full cross-section of a chamber 14. In this case one could incorporate a packing material in chamber 14 to increase the deaeration efficiency.

In the alternative deaeration unit 2" shown in Figure 4 the water is introduced into the bottom of the deaeration unit by riser 5" and passes upwards through upstanding jets 15 or any other device which enables water to fall through a gas space 16 before meeting the continuous body of water.

The deaeration unit may even include devices involving a downflow of water through a turbulent mass of air bubbles.

Instead of the bypass weir a passage isolated by a stop log or pen stock could be used. However, the advantage of a weir is that it needs no adjustment or movement when the deaeration unit is brought into service. Providing the head loss across the bypass weir is slightly in excess of that within the deaeration unit flow will pass through the deaeration unit preferentially once the syphon has been primed.

CLAIMS

1. Water filtering apparatus comprising a granular media filter and a deaeration unit for reducing the degree of saturation of air or other gases in the water to be filtered to a level below that of equilibrium with the atmosphere prior to the water encountering the filter media, the deaeration unit being in the form of a syphon comprising a riser, a downcomer and a cascade between the riser and the downcomer, which downcomer is arranged to discharge into an open passage or tank in use beneath the surface of water in the open passage or tank, the arrangement being such that air or gas removed from the water in the cascade is re-entrained and carried down in the downcomer to the open passage or tank where the entrained air or gas rises to the surface and escapes.

2. The water filtering apparatus of Claim 1, wherein the arrangement is such that the flow velocity in the downcomer exceeds 0.3m/sec.

3. The water filtering apparatus of Claim 1 or Claim 2, further comprising a bypass passage connected between the inlet end and the outlet end of the deaeration unit.

4. The water filtering apparatus of Claim 4, wherein the bypass includes a weir.

5. Water filtering apparatus, substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

6. A method of treating water wherein the degree of saturation of natural dissolved air or other gases in the water is reduced below that of equilibrium with the atmosphere by passing the water through a deaeration unit in the form of a syphon comprising a riser, a downcomer and a cascade between the riser and the downcomer, re-entraining air or gas removed from the water in the cascade in the downcomer, and discharging the water from the lower end of the downcomer into an open passage or tank and beneath the surface of water therein where the entrained air or gas rises to the surface and escapes and from where the water is then passed to a granular media filter over which is maintained a depth of water less than that which would have been necessary to avoid air blinding of

the filter had the degree of saturation of dissolved air or other gas not been reduced.

7. The method of Claim 6, wherein the flow velocity in the downcomer exceeds 0.3m/sec.

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